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Switch to etravirine for HIV-positive patients receiving statin treatment: a prospective study

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Abstract

Background: Life style changes and statins are the cornerstones in management of dyslipidemia in HIV-infected patients. Replacement of an antiretroviral therapy (ART) component is a proposed therapeutic strategy to reduce cardiovascular risk. In dyslipidemic HIV-positive patients, we assessed the efficacy of replacing boosted protease inhibitor (bPI) or efavirenz (EFV) by etravirine (ETR) as an alternative to statin therapy.

Materials and methods: A prospective, open-label, multicentre, 12-week study of HIV-infected patients on ART including bPI or EFV, and statin treatment. Four weeks after statin interruption, bPI or EFV were switched to ETR (400 mg, 8 weeks) if serum low-density lipoprotein cholesterol (LDL-c) was ≥ 3 mmol/L. The primary endpoint was the proportion of patients on ETR with no indication for statin treatment at study completion. Serum levels of HIV-RNA, lipids, and biomarkers of cardiovascular disease were also measured. (ClinicalTrials.gov: NCT01543035).

Results: The 31 included patients had a HIV1-RNA <50 copies/mL (median age, 52 years; median CD4, 709 cell/mL; median LDL-c, 2.89 mmol/L), 68% were on EFV, 32% on bPI. At week 4, 27 patients switched to ETR. At study completion, 15 patients (56%) on ETR did not qualify for statin treatment. After the ETR switch, serum levels of the cardiovascular biomarkers sICAM and MCP1/CCL2 decreased by 11.2% and 18.9%, respectively, and those of CCL5/RANTES and tissue inhibitor of metalloproteinase-1 increased by 14.3% and 13.4%, respectively, indicating reduced cardiovascular risk. There were no notable treatment-related adverse events.

Conclusions: Replacing bPI or EFV by ETR is a viable strategy to obviate primary prevention statin treatment.

Introduction

Dyslipidaemia is common among HIV-infected individuals and has been associated with the HIV infection itself and antiretroviral treatment-induced metabolic disorders [1-6]. Dyslipidaemia is associated with the development of cardiovascular disease in HIV-positive patients on anti-retroviral therapy (ART) [7-9]. Moreover, plasma

levels of several markers of cardiovascular disease are positively associated with HIV-RNA replication [10]. Therefore, HIV-positive patients are often prescribed lipid-lowering drugs, such as statins, for primary prevention of cardiovascular disease. However, the relationship between specific antiretroviral drugs, known risk factors, and biological markers is unclear.

The replacement of antiretroviral drugs rather than adjunction of an anti-lipidaemic drug is a recommended strategy in the 2013 European AIDS Clinical Society (EACS) guidelines [11], considering the potential risk of drug-drug interactions between ART and statins [12] and the importance of reducing pill-burden. This treatment strategy might also decrease the levels of atherosclerotic inflammatory biomarkers.

We have, together with other groups, previously highlighted the beneficial effect of etravirine (ETR) on lipid profile [13-14], and we aimed to investigate the efficacy and safety of replacing ritonavir-boosted lopinavir (LPV/r), atazanavir (ATZ/r), darunavir (DRV/r), or efavirenz (EFV) with etravirine (ETR) as a strategy to obviate statin treatment in patients with suppressed viremia (HIV RNA below 50 copies/mL) and no history of cardiovascular events.

In addition, we assessed the effects of this treatment on serum levels of biomarkers of endothelial activation, pro-atherosclerotic inflammatory cytokines and chemokines, adipocytokines, and metalloproteases and their inhibitors.

Subjects and Methods

Study design and population

This was a 12-week prospective, open label, multicentre, phase III study carried out in 6 sites participating in the Swiss HIV Cohort Study (SHCS) in Switzerland between February 2012 and December 2013. The study was approved by the ethics committee of each site and conducted according to Good Clinical Practices [15] and applicable laws and regulations. All patients provided informed consent. (ClinicalTrials.gov identifier, NCT01543035).

Eligible for study inclusion were HIV-infected adults (18–70 years old) with stable, undetectable HIV-1 RNA (less than 50 copies/mL for at least the 3 previous months) on combined ART with boosted ATZ, DRV, LPV, or EFV, and on statin therapy for primary prevention since at least 3 months, with no history of hyperlipidaemia before ART initiation. Non-inclusion criteria were as follows: >20% ten year cardiovascular risk using the Swiss Atherosclerosis Association GSLA score [16]; use of statins before ART initiation; diabetes; and history of drug resistance mutation (except for K103N).

At baseline, all participants interrupted their statin treatment for 4 weeks. At week 4, patients with serum levels of low-density lipoproteins (LDL-c) ≥ 3 mmol/L, i.e., those qualifying for continued statin treatment, were switched from the on-going PI or EFV to ETR, 400 mg (2 tablets of 200 mg) once daily for 8 weeks, while patients who had lower levels of LDL-c continued the on-going ART without statin treatment. All patients were followed up for the subsequent 8 weeks, with an optional visit 2 weeks after the ETR switch to assess possible side effects. We performed laboratory biochemical tests for lipid profile, liver function, glycaemia, HIV-1 RNA, and cardiovascular risk profile, as well as clinical assessment at baseline (week 0), switch to ETR (week 4), and end of study (week 12).

Outcomes

The primary endpoint of the study was the proportion of patients not qualifying for statin treatment 8 weeks after the ETR switch, i.e. at study completion (week 12).

The need for statin treatment was determined according to the 2013 treatment guidelines of the EACS for patients with low-to-moderate risk of cardiovascular disease on the basis of the Framingham CHD Score [17] and the Swiss cardiovascular risk score GSLA. In a post-hoc analysis we applied the recently issued 2013 ACC/AHA guidelines (10-year atherosclerosis and cardiovascular risk) [18].

Secondary endpoints included changes in serum level of lipids and biomarkers relative to baseline at week 4 for all included patients; changes relative to week 4 at

the end of study were determined for patients who switched to ETR. We also recorded serum levels of HIV-RNA at baseline and study completion.

Biochemical determinations

Lipid profile determination was performed centrally (Covance laboratory, Meyrin, Switzerland, LAP Number 4658701, AU-ID 1190700). LDL-c was calculated with the Friedwald formula or measured directly if triglycerides (TG) were above 4.52 mmol/L. All other tests were performed locally in quality controlled, SHCS (Swiss HIV Cohort Study, www.shcs.ch) -affiliated laboratories. All the above tests were performed at week 0, 4, and 12. HIV-1 RNA was measured using Roche COBAS TaqMan HIV-1 test version 2.0 (COBAS AmpliPrep; Roche Diagnostic, Basel, Switzerland) and was considered undetectable if below 50 copies/mL.

Inflammatory markers were measured retrospectively, at study completion, at the Department of Laboratory Medicine, Cardiology Laboratory of the University Hospital of Geneva.

We performed batch measurements using colorimetric Enzyme-Linked Immunosorbent Assay (ELISA) following manufacturer's instructions for serum soluble intercellular adhesion molecule (sICAM)-1, soluble vascular cell adhesion molecule (sVCAM)-1, interleukin (IL)-6, monocyte chemoattractant protein-1 (MCP-1)/CCL2, and tumour necrosis factor (TNF)-alpha (all from BioLegend, San

Diego, California, USA); for tissue inhibitor of metalloproteinase (TIMP)-1, TIMP-2, matrix metalloproteinase (MMP)-8, macrophage inflammatory protein (MIP)-1 β /CCL4, regulated upon activation, normal T-cell expressed, and secreted (RANTES)/CCL5, E-selectin, L-selectin, C-reactive protein (CRP) and leptin (all from RayBiotech Inc., Norcross, GA, USA); for serum tissue inhibitors of metalloproteases, TIMP-1, TIMP-2, and TIMP-3 (all from Abcam, Cambridge, MA, USA); for serum adiponectin, MMP-8, MMP-9, and soluble (s)P-selectin (all from R&D Systems, Minneapolis, Minnesota, USA); and for plasma D-dimer (Technoclone GmbH, Vienna, Austria). Mean intra- and inter-assay coefficients of variation (CV) were below 15% for all markers.

The limits of detection of the markers were as follows: 0.78 ng/mL for sICAM-1, 1.56 ng/mL for sVCAM-1, 24.69 pg/mL for TIMP-1, 1.6 pg/mL for TIMP-2, 156 pg/m for TIMP-3, 0.312 ng/m for MMP-9, 8.23 pg/m for MMP-8, 2.74 pg/mL for RANTES/CCL5, 24.69 pg/mL for E-selectin, 0.99 ng/mL for sP-selectin, 0.102 ng/mL for L-selectin, 2.469 pg/mL for CRP, 15.6 pg/mL for TNF- α , 7.8 pg/mL for IL-6, 1.64 pg/mL for leptin, 3.9 ng/mL for adiponectin, 7.8 pg/mL for MCP-1/CCL2, 4.10 pg/mL for MIP-1 β /CCL4 and 212 ng/mL for D-dimer.

Among promising cardiovascular mediators involved in atherosclerotic acceleration in HIV patients [10, 19], we focused on markers of endothelial activation (soluble adhesion molecules, such as sICAM, sVCAM, E-Selectin, sP-selectin, L-Selectin), pro-atherosclerotic molecules cytokines and chemokines (CRP, IL-6, TNF α ,

MCP1/CCL2, MIP-1-beta/CCL4 and CCL5 RANTES), adipocytokines (leptin and adiponectin) and coagulation factors (d-dimer). Considering the potential vulnerable properties of metalloproteases on atherosclerotic plaques [20-21], we investigated serum levels of the collagenase MMP-8, the gelatinase MMP-9 and their tissue inhibitors (TIMP-1, -2 and -3).

Data collected during the study visits, including laboratory values, were monitored, and entered into a CRF compliant electronic database (SecuTrial®).

Safety assessment

Adverse Events were graded according to the Division of AIDS (DAIDS) Table for Grading of Severity of Adult Adverse Events, (Version 1.0 December 2004, Clarification August 2009, www.niaid.nih.gov). Reporting of Severe Adverse Events was to be compliant with applicable Swiss laws and regulations.

All included patients were followed up for safety assessment until the week 12 visit.

Statistical Analysis

Sample size estimation

The following hypotheses were made: during the 4 weeks without statin treatment, up to 10% of the patients would show LDL-c value below the threshold level of 3 mmol/L and therefore would not be eligible for the drug switch to ETR. The proportion of patients in need of statin treatment would decrease to 25% at study completion. With a power of 80% and a significance level of 5%, we estimated a total of 40 eligible patients would be required to show a decrease of at least 25% of patients in need of statin.

Data Analysis

Baseline characteristics included: age, weight, sex, menopausal status, pregnancy, smoking status, systolic blood pressure, myocardial infarct/stroke in first degree relative, diabetes, treated hypertension, cardiovascular risk level (GSLA score [16], Framingham Hard CHD Score [17]), HIV stage according to the Centre for Disease Control (CDC) classification, on-going ART treatment [use of (non)nucleoside reverse transcriptase inhibitors, ((N)NRTI), ritonavir boosted protease inhibitor (bPI), integrase inhibitors], statin treatment, total cholesterol (TC), high-density lipoprotein (HDL-c), LDL-c, TG, CD4 cell count, and HIV-1 RNA. The quantitative variables were summarized as median and interquartile ranges (IQR), while qualitative variables were presented as frequencies or percentages.

The primary endpoint, defined as the proportion of patients not qualifying anymore for statin treatment 12 weeks after inclusion into the study (i.e. after 8 weeks of ETR treatment) according to EACS 2013 recommendations [11], was analyzed using Mac Nemar chi-squared test with a threshold of 5%. We repeated a similar analysis using the Swiss cardio-vascular risk score GSLA [16] and 2013 ACC/AHA guideline (10 year ASCVD risk) [18].

We analyzed changes in lipid profile and biomarkers as change from baseline to week 4 for all the 31 enrolled patients and as change from week 4 to week 12 (8 weeks) for the 27 patients who switched to ETR. Both absolute and percentage changes were assessed and compared using a Wilcoxon matched-pair signed-rank test with an alpha threshold of 5%. Correlations between continuous variables were evaluated using Spearman's rank correlation test.

Univariable and multivariable logistic regressions were performed to identify factors associated with the impact of ETR switch on statin indication. The univariable logistic regression model included age, sex (women *vs.* men), time since HIV diagnosis (>10 years *vs.* ≤10 years), CD4 cell count (>500 cell/mL *vs.* ≤500 cell/mL), baseline ART class (EFV *vs.* bPI-based regimen), known hypertension (Yes *vs.* No), smoking status (active smoker *vs.* non-smoker), LDL-c at week 4 after statin interruption, statin half-lives ('long acting' (atorvastatin and rosuvastatin) *vs.* 'short acting' (pravastatin) [22]) and the 8-weeks percentage change relative to week 4 (week 4 – week 12) of the four biomarkers MCP-1/CCL2, sICAM, CCL5/RANTES and TIMP-1, which changes were statistically significant between the 2 timepoints.

The multivariable linear regression model included all variables with a $p < 0.200$ in the univariable model.

The frequency of adverse event of all patients until study completion was recorded regardless of the ETR switch. We also analyzed modification of liver and kidney function (ASAT [UI], ALAT [UI], serum creatinine [$\mu\text{mol/L}$]) and glycaemia (mmol/L) from week 4 to week 12 for all patients who completed the trial. Eight-week absolute changes were assessed and compared using a Wilcoxon matched-pair signed-rank test with an alpha threshold of 5%.

All statistical analyses were performed using STATA Statistical Software, Release 12.0 (Stata Corporation, and College Station, USA). The study results were reported according to STROBE statement [23].

Results

Baseline Characteristics

From February 2012 to April 2013, 34 patients were screened at the 6 study sites within the SHCS (Fig. 1). Three patients were not included, each for one of the following reasons: history of known hypercholesterolemia before ART initiation, $>20\%$ cardiovascular disease risk score according to Swiss guidelines, and statin interruption during the screening period. Of the 31 enrolled patients, a majority were

men (n = 25, 81%). Median age was 52 years (IQR, 46–60 years) (Table 1). All participants had a long history of HIV infection with a median of 11.5 years (IQR, 7.7-18.9) since diagnosis. At enrolment, the median CD4 cells count was 709 cells/mL (IQR, 543–851 cells/mL), and all patients had HIV-1-RNA \leq 50 copies/mL. The ART combination at inclusion included EFV for 21 patients (68%) while 10 patients (32%) were on a ritonavir-boosted regimen (5 on LPV/r, 4 on ATV/r, 1 on DRV/r). Twelve patients (39%) were active smokers, 10 patients (32%) were treated for high blood pressure and 2 patients had a family history of cardiovascular disease. Statin treatment was pravastatin for 15 patients (48%), rosuvastatin for 13 patients (42%) and atorvastatin for 3 patients (10%), with 9 patients (69%) on a daily dose of rosuvastatin at 10 mg or higher, 12 patients (80%) on pravastatin at 40 mg or higher, and 2 patients (67%) on atorvastatin 20 mg or higher.

Changes in lipid profile 4 weeks after statin withdrawal

Between week 0 and week 4, median LDL-c increased by 31.0%, median TC increased by 21.9%, and median TG by 28.4% (Table 2). These changes were statistically significant ($p < 0.001$), no significant change was observed in HDL-c (Figure 2). Two participants had an LDL value < 3 mmol/L and were therefore not switched to ETR. Of the remaining patients, 2 were excluded because of HIV-1 RNA > 50 copies/mL or the drug resistance mutation M184V. Therefore, of the 31 included patients, 27 patients switched to the ETR treatment.

Statin indication at study completion (8 weeks after switch to ETR)

At study completion, of the 27 patients who switched to ETR, 25 patients (93%) had a viral load below the detection threshold of 50 copies/mL (two patients had a VL between 50 and 100 copies/ml). We observed statistically significant decreases in total cholesterol (-0.88 mmol/L), LDL-c (-0.49 mmol/L), and TG (-0.51 mmol/L) between weeks 4 and 12 (Figure 2).

Primary efficacy endpoint

At study completion, 15 (56%) of the 27 patients who switched to ETR did not qualify for statin treatment according to EACS recommendations ($p = 0.0001$), and 14 (52%) patients according to the Swiss GSLA scores ($p = 0.0001$). A *post hoc* analysis was performed to evaluate the study results using the new American 2013 ACC/AHA guidelines: only 10 patients (37%) would not qualify anymore for statin treatment ($p = 0.002$) (Figure 3).

Cardiovascular biomarkers

Absolute and percentage changes in inflammatory biomarkers were not significantly different between baseline and week 4 after the statin interruption (Table 2). In patients who switched to ETR, we observed a decrease in sICAM levels of 11.2% ($p = 0.039$), and a decrease in MCP1/CCL2 levels of 18.9% ($p = 0.017$) between weeks 4 and 12, i.e. during the 8 weeks of ETR administration. In addition, the levels of the pro-atherosclerotic chemokine CCL5/RANTES increased by 14.3% ($p =$

0.012), and those of TIMP-1 increased by 13.4% ($p = 0.039$). Other biomarkers showed no significant changes between the different time points, while D-dimers, IL-6 and TNF-alpha remained below the detection thresholds throughout the study period.

Adjusted multivariable analysis

The only variable found to be related to the absence of indication for statin treatment at study completion, after 8 weeks on ETR was age (OR: 1.18 (95% CI, 1.02-1.37)), after adjustment for both LDL-c at week 4 (OR: 0.17 (95% CI, 0.02-1.36)) and percentage change of TIMP-1 biomarker (OR: 1.02 (95% CI, 1.00-1.01)) (Table 3).

Safety

No Serious Adverse Event was reported during the study. One patient discontinued ETR treatment on his own initiative after 24 days due to dizziness, fatigue and depression, which were graded as mild by the investigator. Fifteen clinical events were reported in 11 patients. All events were graded as mild or moderate in severity and none were judged by the investigator to be related to the study drug, or the statin interruption. Nine events were considered possibly related to ETR: one case of grade 1 rash occurred 2 weeks after ETR initiation, and a case of acute renal failure was reported at the end of the study period. Events of dizziness, vomiting, left intercostal pain, and a grade 1 elevation of alanine aminotransferase were considered as related to the ETR treatment. No significant increase in liver function test was recorded, but

a small significant increase in serum creatinine ($+4 \mu\text{mol/L}$, IQR $-2 - 9$, $p=0.018$) and a decrease in glycaemia (-0.25 mmol/L , IQR $-0.60 - 0.15$, $p=0.028$) were observed in the 29 patients who completed the trial, though without clinical impact.

Discussion

Our study shows that HIV-infected individuals on statin treatment in whom the boosted PI or EFV was replaced with ETR can avoid the use of statins in 56% of the cases (primary efficacy endpoint). Over the study period, these patients showed a significant decrease in the levels of serum lipids (though not as large as when they were on statin treatment) and in pro-inflammatory markers, suggesting reduced risk of cardiovascular disease.

In addition, we confirmed that statin interruption did not cause any Serious Adverse Event as expected from an earlier report [24], and no cardiovascular disease was observed during the 12-week study period.

Traditional CV risk factors, HIV-induced immune activation, as well as the metabolic consequences of some antiretroviral drugs contribute to a 2-fold increase in the risk of cardiovascular disease in HIV-infected patients. Recommended preventive interventions target modifiable risk factors such as smoking, and dyslipidaemia. Replacing a combined ART component by a lipid-friendly drug has many advantages, including economic and practical considerations. However, despite

the positive effect on lipids of ETR, a drug such as EFV is available in combination as a single fixed-dose pill and is often preferred by patients. Other drugs may have a safety and lipid-neutral profile similar to ETR, but have not been evaluated so far with the objective of a statin-sparing strategy.

Our results confirm the observations from clinical trials comparing newer drugs with standard treatments including boosted PI. In the Switch-EE study [13], patients switched to ETR had lower lipid plasma levels than when on EFV. In the SENSE study [25] both total cholesterol and LDL-c were lower in patients on ETR as compared with patients on EFV (number of patients with grade 3 or 4 elevation of total cholesterol was 1% vs. 8%). In the C227 trial [26], exploring two treatment regimens (ETR+2NRTI or boosted PI+2NRTI) after an NNRTI-first line failure, lipid and bilirubin elevations were less frequent in the ETR arm. These observations can be applied in a clinical pragmatic intervention to reduce lipid levels and therefore cardiovascular risk.

The so-called “neutral” effect on lipids of ETR has been showed in studies using placebo [27] and this may explain its favourable profile compared with antiretroviral drugs known for their unwanted effect on lipids. This effect is usually measured at 24 weeks in clinical trial, but seems to start earlier, as in our study.

Our study focused on numerous cardiovascular risk biomarkers, including active factors of atherogenesis previously investigated in both high-risk populations as well

as HIV patients [10, 28]. The levels of these mediators in the present study were similar to those observed in previous studies [29]. Serum levels of IL-6, TNF-alpha and D-dimer were confirmed to be very low in HIV patients as well as in other subjects with elevated cardiovascular risk [10, 28]. These results indicate that despite their promise in other cohorts [19], these mediators might not be useful in HIV patients. Alternatively, our data might also suggest the need for methods providing a higher sensitivity for investigating these biomarkers in HIV-positive patients. During the four weeks following statin interruption no significant modification in any of these biomarkers was seen, in contradiction to previous studies that showed that statins lower serum CRP levels [30-31]. The discrepancy could be due to the relatively short follow-up; four weeks might not be enough time to observe an inflammatory rebound due to statin cessation.

The switch to ETR was associated with a protective decrease in sICAM (a marker of endothelial activation) and MCP1/CCL2 (a pro-atherosclerotic chemokine), and a beneficial increase in TIMP-1. These changes indicate a potential direct cardiovascular protection induced by ETR that may improve endothelial activation, protect from the deleterious activities of MMP, and reduce atherosclerotic inflammation (via MCP-1/CCL2-mediated pathways). The weak association between lipid profile and biomarkers (only shown for TGs and MCP-1/CCL2) suggests that ETR might reduce the cardiovascular risk not only via improvement in the lipid profile, but also via biomarkers.

A study in healthy volunteers [32] showed no effect of ETR on inflammatory biomarkers and endothelial function and finally on CV risk. ETR was introduced over 28 days with no significant changes, but the study population was very different: not only patients had no HIV infection but they had also a normal lipid profile, making comparisons difficult. In addition the ETR exposure was only of 28 days that could be a too short period to observe changes.

We also found a weak but statistically significant increase in the serum levels of the chemokine CCL5/RANTES in HIV-infected patients on ETR. This chemokine was recently shown to activate both circulating leukocytes and platelets and potentially increase cardiovascular vulnerability [28, 33]. Considering the design and low number of patients enrolled in our study, we might only speculate that results on this marker merit additional investigations. In addition, we cannot conclude whether ETR-associated increase of CCL5 levels is limited to the first eight weeks of treatment, or sustained over time.

Our study has several limitations. It was not a randomised design, and bias in selection of participants cannot be excluded. The lack of a control group prevents the clear attribution of the effect of the intervention, but previous studies' results and the appearance of the effect after ETV introduction make the relation plausible.

Recruitment varied by centre depending on the number of patients already receiving statin treatment. Fewer patients were receiving statin treatment than expected, while many patients were excluded because of previous cardiovascular disease and/or

documented drug mutations. Pill burden and refusal to change regimens were the main reasons for non-participation, especially for patients receiving a once daily fixed-dose combination such as Atripla®. As a result of insufficient recruitment, the desired sample size of 40 included patients was not achieved, thereby reducing the power of the study and the possibility to study additional predictive factors.

The criteria for the initial indication of statin treatment were not known and probably differed widely across study sites, which adds possible confounding factors not considered in our analysis. The study has a short follow-up period, which does not allow evaluation of the long-term effect of the proposed treatment strategy, but in a previously reported clinical trial, the effect of switch to ETR on lipid profile could be maintained over the follow-up period of 48 weeks [34]. We did not collect information on nutrition or physical activities, which may have contributed to the lipid changes over the study period.

In conclusion, although surrogate experimental biomarkers of CV risk have been widely investigated, their clinical use requires further validation in this population. Our preliminary results demonstrating the lowering effect of ETR on circulating pro-inflammatory markers cannot yet be considered as a relevant reduction in CV risk for HIV patients. Combination of serum inflammatory biomarkers with other validated and classical parameters (i.e. LDL-cholesterol) remain essential when assessing the CV risk. Additional larger trials are needed to clarify the role of some biomarkers such as CCL2 to further improve the CV risk assessment of HIV-infected patients.

While indications for statin use in primary prevention of cardiovascular disease are controversial [16-18], the present study indicates that out of the 27 HIV-positive patients who switched to ETR for 8 weeks, 10–15 patients (depending on the guideline used) or 37–56% no longer required statin treatment. In view of the importance of this finding for the management of HIV patients, further investigations, including prospective, large-scale, randomised studies with a longer follow-up period, are required to justify the switch to ETR and removal of statins from the treatment regimen in HIV patients with a low-to-moderate Framingham risk score.

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Table 1. Baseline characteristics of the 31 included patients.

Characteristic	Value
Age, years, median (IQR)	51.7 (46.2-59.6)
Weight, kg, median (IQR)	70 (64-82)
Gender	
Men	25 (81%)
Women	6 (19%)
Menopausal women	4 (67%)
Active Smoker	12 (39%)
Myocardial infarction or stroke in 1st degree related person	2 (7%)
Known hypertension	10 (32%)
GSLA Score	
Low risk < 10%	29 (94%)
Moderate risk 10-20%	2 (6%)
CD4 ⁺ cells/mL (IQR)	709 (543-851)
Time since HIV diagnosis, years (IQR)	11.5 (7.7-18.9)
HIV staging (CDC categories)	
A	15 (48%)

B	8 (26%)
C	8 (26%)
<hr/>	
On ART treatment	31 (100%)
First line regimen	3 (10%)
Current NNRTI	21 (68%)
Current NRTI	31 (100%)
Current PI	10 (32%)
Current INI	1 (3%)
HIV-RNA \leq 50 copies/mL	31 (100%)
Statins in use at study entry:	
Atorvastatin	3 (10%)
Pravastatin	15 (48%)
Rosuvastatin	13 (42%)

IQR = Inter-quartile Range CDC = Centre for Disease Control, USA, NNRTI = non-nucleoside reverse-transcriptase inhibitor, NRTI = nucleoside reverse-transcriptase inhibitor, PI = protease inhibitor, INI = integrase inhibitor.

Table 2: Lipid profile and cardiovascular biomarker values

	Patients who stopped statin (N=31)			Patients who switched to ETR (N=27)		
	Week 0	4-week absolute change	4-week percentage change	Week 4	8-week absolute change	8-week percentage change
	Median (IQR)	(Week 0 – Week 4) Median (IQR)	(Week 0 – Week 4) Median (IQR)	Median (IQR)	(Week 4 – Week 12) Median (IQR)	(Week 4 – Week 12) Median (IQR)
<i>Lipids profile</i>						
LDL –C (mmol/l)	2.89 (2.59-3.54)	0.99 (0.54-1.52)***	31.03 (13.67-65.86)***	4.30 (3.75-4.75)	-0.49 (-1.16; 0.17)*	-11.86(-24.17-3.94)*
HDL-C (mmol/l)	1.53 (1.27-1.68)	-0.07 (-0.19-0.05)	-3.41 (-12.76-3.68)	1.46 (1.25-1.46)	0.01 (-0.17; 0.09)	0.68(-7.33-6.67)
Total Cholesterol (mmol/l)	5.58 (5.04-6.24)	1.25 (0.78-1.60)***	21.85 (11.83-31.77)***	6.97 (6.44-7.36)	-0.88 (-1.38; -0.31)***	-13.21(-19.12--3.85)***
Triglycerides (mmol/l)	1.63 (1.22-2.62)	0.39 (0-0.62)*	28.36 (0-40.82)**	2.08 (1.37-3.01)	-0.51 (-1.16;-0.06)**	-27.36(-39.23--4.65)**
<i>Biomarkers</i>						
Endothelial activation:						
sICAM (ng/mL)	278.56(223.69-336.79)	2.00(-72.12-71.14)	0.46(-21.72;32.77)	272.46(225.6-355.42)	-34.45(-67.04-18.74)*	-11.21(-22.72;4.58)*
sVCAM (ng/mL)	426(366.56-560.2)	-54.87(-123.71-47.31)	-13.34(-28.87;5.29)	382.95(289.33-510.44)	8.33(-52.19-78.57)	2.67(-9.07;28.96)
E-Selectin (ng/mL)	33.66(25.45-44.88)	-1.56(-10.14-5.42)	-5.41(-25.76;14.53)	33.65(18.82-49.15)	-2.85(-7.66-6.43)	-7.75(-24.12;22.58)
sP-selectin (ng/mL)	93.53(66.86-116.05)	-2.26(-27.95-13.31)	-2.33(-24.45;17.46)	89.07(50.76-105.32)	-3.93(-17.53-9.99)	-3.8(-19.62;11.99)
L-Selectin (ng/mL)	1783.36(1174.5-2721.42)	168.45(-345.32--602.46)	8.21(-20.32;38.3)	1953.64(1399.46-2500.62)	-121.57(-829.88-657.93)	-7.93(-34.91;43.88)
Pro-atherosclerotic molecules cytokines and chemokines:						
CRP (µg/mL)	2.98(0.51-9.25)	0.15(-2.37-1.42)	12.81(-38.99;138.96)	2.60(1.28-7.53)	-0.55(-2.75-2.2)	-20.05(-46.88;82.22)
IL-6 pg/mL	7.80(7.80-7.80)	0(0-0)	0(0;0)	7.80(7.80-7.80)	0(0-0)	0(0;0)
TNF alpha (pg/mL)	15.60(15.60-15.60)	0(0-0)	0(0;0)	15.60(15.60-15.60)	0(0-0)	0(0;0)
MCPI/CCL2 (pg/mL)	102.17(74-188.66)	2.03(-19.72-33.4)	2.5(-16.37;26.52)	114.73(73.8-179.89)	-14.24(-34.38--0.98)*	-18.92(-32.57;-0.94)*
MIP-1Beta/CCL4 (pg/mL)	104.27(81.4-135.17)	1.87(-13.2-20.31)	1.87(-15.99;20.86)	102.79(74.84-125.35)	-2.74(-11.48-9.79)	-3.97(-11.15;15.09)
CCL5 RANTES (ng/mL)	69.53(33.46-103.89)	-3.42(-28.4-8.09)	-5.88(-38.91;13.87)	46.88(38.25-72.55)	6.89(-9.92-26.33)	14.27(-14.84;80.72)*

Adipocytokines:						
Leptin (ng/mL)	3.87(1.83-14.03)	-0.19(-1.95-0.61)	-10.22(-48.15;28.9)	2.68(1.41-8.27)	0.1(-1.04-1.44)	9.28(-32.38;79.67)
Adiponectin (µg/mL)	6.55(4.5-9.65)	0.03(-0.78-1.76)	0.42(-20.52;30.68)	7.46(4.77-10.23)	-0.55(-2.57-0.52)	-12.85(-26.77;8.67)
Metalloproteases and inhibitors:						
MMP-9 (ng/mL)	502.28(358.78-719.29)	6.41(-192.38--74.81)	1.79(-41.51;26.65)	411.18(305.09-723.02)	-51.8(-218.3-43.95)	-12.88(-38.63;32.57)
MMP-8 (ng/mL)	3.18(1.75-4.7)	-0.44(-1.6-0.73)	-17.14(-40;34.75)	2.72(1.17-4.26)	-0.24(-1.04-0.93)	-14.55(-44.22;41.19)
TIMP-1 (ng/mL)	433.74(354.16-549.09)	-11.77(-96.5-89.51)	-2.58(-24.54;21.28)	429.51(338.51-523.25)	66.31(-39.23-297)*	13.43(-9.02;100.03)*
TIMP-2 (ng/mL)	68.53(60.98-85.73)	-0.61(-9.47-17.42)	-0.82(-9.79;20.31)	73.68(62.27-82.67)	-1.41(-12.21-22.17)	-1.94(-11.76;27.34)
TIMP-3 (ng/mL)	2.7(1.99-4.7)	-0.13(-1.04-0.81)	-1.43(-40.44;44.67)	2.49(1.58-4.22)	-0.18(-1.43-0.52)	-11.19(-46.92;38.76)

CRP = C-reactive protein, IL = interleukin, MCP = monocyte chemoattractant protein, MIP = macrophage inflammatory protein, MMP = matrix metalloproteinase, RANTES =

Regulated upon Activation, Normal T-cell Expressed, and Secreted, sICAM = serum soluble intercellular adhesion molecule, sVCAM = soluble vascular cell adhesion molecule, TIMP = tissue inhibitor of metalloproteinase, TNF = tumour necrosis factor.

* p<0.05, ** p<0.01, *** p<0.0001.

Table 3: The association between baseline characteristics and the absence of indication for statin treatment at study completion.

Factors	Univariate OR (95% CI)	P Value	Multivariate OR (95% CI)	P Value
Age (in year)	1.13 (1.01-1.27)	0.028	1.18 (1.02-1.37)	0.028
Sex:				
- Male	1			
- Female	0.91 (0.15-5.58)	0.918		
Time since HIV diagnosis:				
- ≤10 years	1			
- >10 years	1.29 (0.26-6.27)	0.756		
CD4 count, cells/mm³				
- ≤500	0.91 (0.15-5.58)			
- >500	1	0.918		
Statin half-life:				
- Short acting statin	1			
- Long acting statin	0.63 (0.14-2.89)	0.548		
Baseline ART treatment:				
- NNRTI (efavirenz)	1			
- Protease inhibitor	0.61 (0.11-3.49)	0.582		
Known hypertension	3.10 (0.47-19.67)	0.240		
Active smoker	0.48 (0.10-2.23)	0.346		
LDL-C value (mmol/L) at week 4	0.32 (0.09-1.17)	0.085	0.17 (0.02-1.36)	0.094
8-week percentage change of laboratory marker TIMP-1	1.01 (1.00-1.03)	0.079	1.02 (1.00-1.01)	0.092

8-week percentage change of laboratory		
marker MCP1-CCL2	1.01 (0.98-1.04)	0.481
8-week percentage change of laboratory		
marker sICAM	0.99 (0.95-1.02)	0.451
8-week percentage change of laboratory		
marker	1.00 (0.98-1.01)	0.488
CCL5_RANTES		
LDL-c = low density lipoprotein cholesterol, MCP = monocyte chemoattractant protein, NNRTI, non-nucleoside reverse-transcriptase inhibitor, OR = odds ratio, RANTES = Regulated upon Activation, Normal T-cell Expressed, and Secreted, sICAM = serum soluble intercellular adhesion molecule, TIMP = tissue inhibitor of metalloproteinase.		

Figure captions

Figure 1. Study flow chart. The flow chart illustrates recruitment and intervention flow of all the patients who were screened at the 6 participating sites.

Figure 2. Lipid profiles at week 0, week 4 and week 12 in the 27 patients who switched to ETR. The serum levels of total cholesterol, low density cholesterol, high density cholesterol and triglycerides were measured at baseline (week 0), 4 weeks after stopping statin treatment (week 4), and 8 weeks after switch to ETR (week 8) in the 27 patients who qualified for the ETR switch out of the 31 included patients. Values presented are the median and interquartile ranges.

Figure 3. Proportion of patients not qualifying for a statin treatment after 8 weeks of ETR treatment. The criteria for qualifying for statin treatment were according to the EACS latest recommendations (blue bar), GSLA (red bar), or 2013 ACC/AHA recommendations (green bar).

Figure 1: Study flow chart.

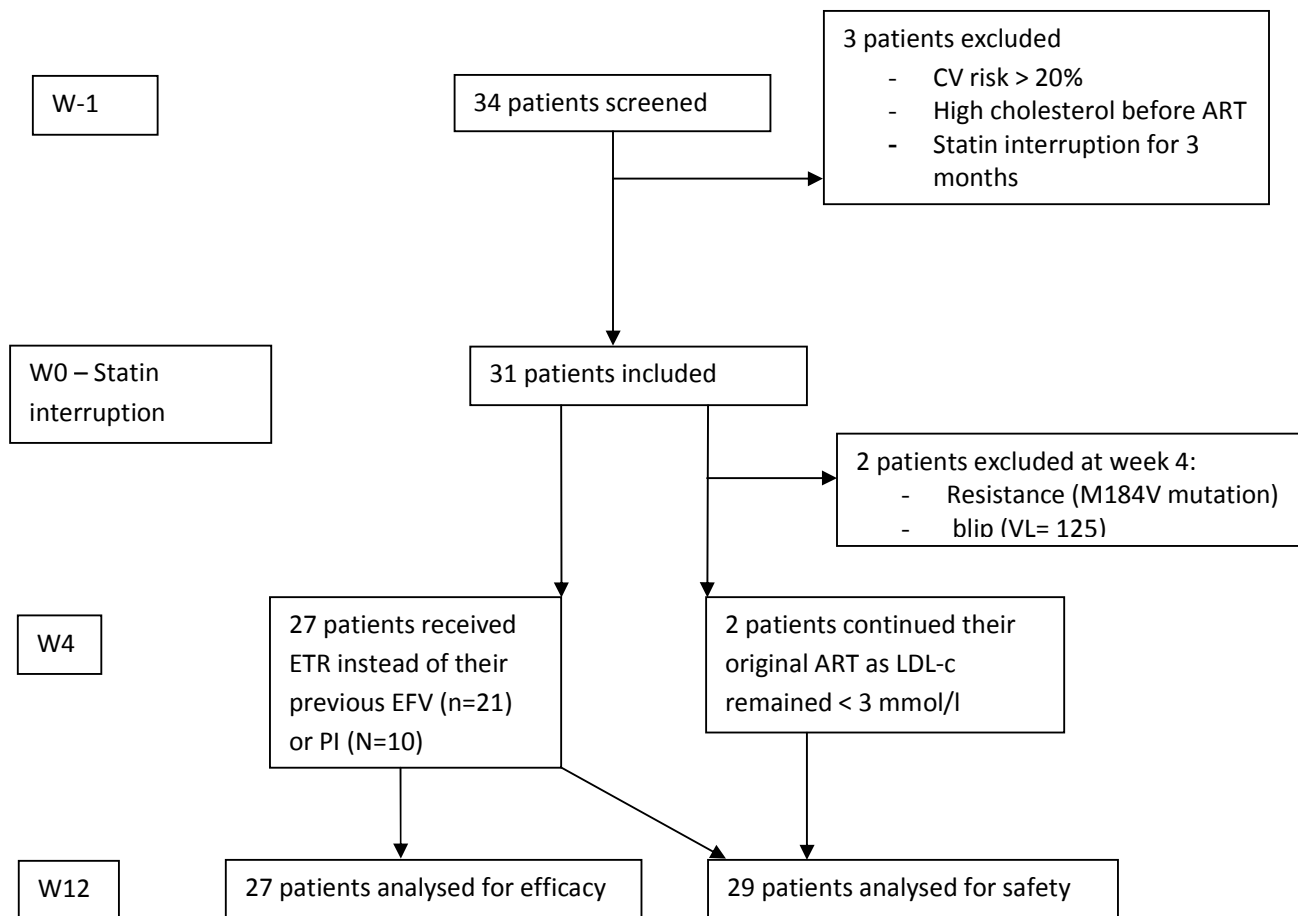


Figure 2: Lipid profiles at week 0, week 4 and week 12 in the 27 patients who switched to ETR.

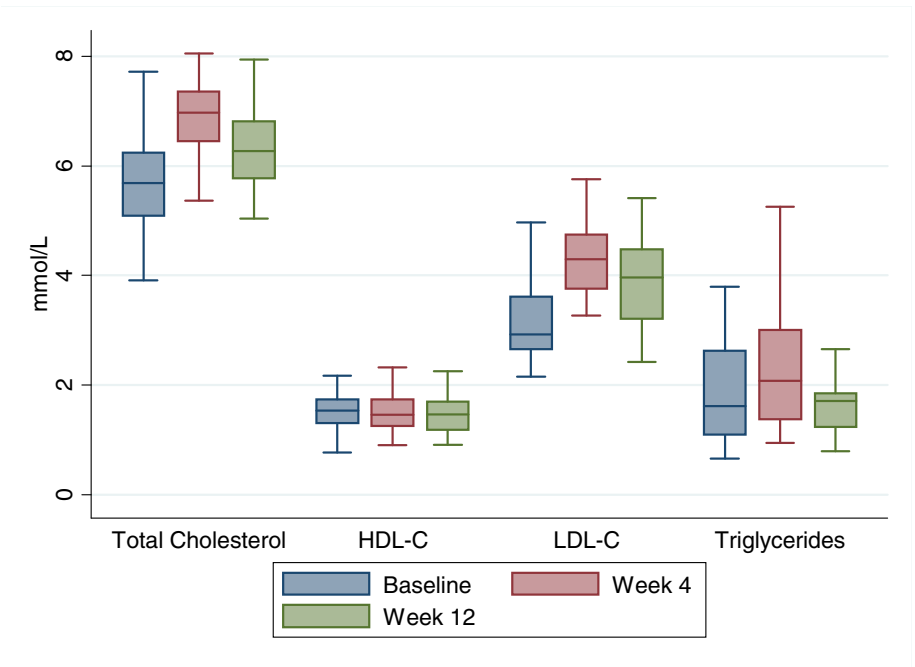


Figure 3: Proportion of patients not qualifying for a statin treatment after 8 weeks of ETR treatment.

